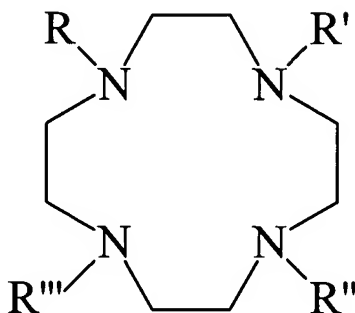


WHAT IS CLAIMED IS:

1. A contrast agent comprising:

a tetraazacyclododecane ligand having a general formula as follows:



wherein pendent arms R, R', R'' and R''' are amides having a general formula: $-CR_1H-CO-NH-CH_2-R_2$, wherein R_1 includes organic substituents and R_2 is not hydrogen; and

a paramagnetic metal ion coordinated to said tetraazacyclododecane ligand.

2. The contrast agent as recited in Claim 1 further including a water molecule associated with said tetraazacyclododecane ligand and said paramagnetic metal ion such that said water molecule has a $\Delta\omega \cdot \tau_M \geq 1$.

3. The contrast agent as recited in Claim 2 wherein said $\Delta\omega \geq 6$ ppm.

4. The contrast agent as recited in Claim 2 wherein
2 said $\tau_M \geq 1 \mu s$.

5. The contrast agent as recited in Claim 1 wherein said
2 paramagnetic metal is selected from the group consisting of:

3 Eu^{3+} ;

4 Tb^{3+} ;

5 Dy^{3+} ; and

6 Ho^{3+} .

6. The contrast agent as recited in Claim 1 wherein said
2 paramagnetic metal is selected from the group consisting of:

3 Pr^{3+} ;

4 Nd^{3+} ;

5 Sm^{3+} ;

6 Er^{3+} ; and

7 Tm^{3+} .

7. The contrast agent as recited in Claim 1 wherein said
2 R_2 does not have a proton exchangeable group.

8. The contrast agent as recited in Claim 7 wherein said
2 R_2 is selected from the group consisting of:

3 Alkyl groups having 20 carbon atoms or less;

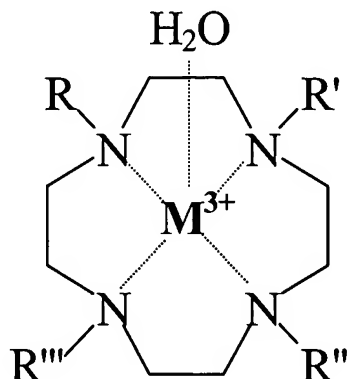
4 Cycloalkyl groups having 20 carbon atoms or less;
5 Alkyloxy groups having 20 carbon atoms or less;
6 Alkyl ethers having 10 oxygen atoms or less and 20 carbon
7 atoms or less; and
8 Polyols having 20 carbon atoms or less.

9. The contrast agent as recited in Claim 1 wherein said
1 R₁ is selected from the group consisting of:

2 H;
3 Alkyl groups having 20 carbon atoms or less;
4 Cycloalkyl groups having 20 carbon atoms or less;
5 Alkyloxy groups having 20 carbon atoms or less;
6 Alkyl ethers having 10 oxygen atoms or less and 20 carbon
7 atoms or less; and
8 Polyols having 20 carbon atoms or less.

10. A method of using a magnetic resonance (MR) contrast agent, comprising:

subjecting a contrast agent contained within a sample to a radio frequency pulse wherein said contrast agent is a tetraazacyclododecane ligand having a general formula of:



wherein pendent arms R, R', R'' and R''' comprise organic substituents and said tetraazacyclododecane ligand further includes a paramagnetic metal ion (M^{3+}) coordinated to said tetraazacyclododecane ligand and a water molecule (H_2O) associated with said tetraazacyclododecane ligand; and

obtaining a magnetization transfer signal by applying a radio frequency pulse at a resonance frequency of said water molecule.

11. The method as recited in Claim 10 wherein said water molecule has a $\Delta\omega \cdot \tau_M \geq 1$.

12. The method as recited in Claim 10 further includes

2 producing a magnetization transfer magnetic resonance image from
3 said magnetization transfer signal.

13. The method as recited in Claim 10 further includes
2 applying said radio frequency pulse as a saturating pulse.

14. The method as recited in Claim 10 further includes
2 said contrast agent with at least one pendent arm containing an
3 amide group.

15. The method as recited in Claim 14 wherein said
2 pendent arms are identical and have the general formula:
3 $-\text{CHR}_1-\text{CO}-\text{NR}_2-\text{R}_3$, wherein R_1 , R_2 and R_3 comprise organic
4 substituents.

16. The method as recited in Claim 14 wherein said
2 R_1 and R_2 are H, and R_3 has the general formula: $-(\text{CH}_2)_n\text{COOR}_4$
3 where

4 $n = 1-20$; and

5 R_4 is selected from the group consisting of:

6 H;

7 Group IA or IIA metal ions; and

8 alkyl groups containing from one to twenty Carbon
9 atoms.

17. The method as recited in Claim 14 wherein said
paramagnetic metal ion is selected from the group consisting of:

Tb³⁺;

Dy³⁺; and

Ho³⁺.

18. The method as recited in Claim 14 wherein said
paramagnetic metal ion is selected from the group consisting of:

Eu³⁺;

Pr³⁺; and

Nd³⁺.

19. The method as recited in Claim 14 wherein said
R₁ and R₂ are H, and R₃ has the general formula: -

(CH₂)_nP(O)(OR₄OR₅) where

n = 1-20;

said R₄ is selected from the group consisting of:

H;

alkaline earth metal ions of Groups IA or IIA; and

alkyl groups containing one to twenty Carbon atoms;

and said R₅ is selected from the group consisting of:

H;

alkaline earth metal ions of Groups IA or IIA; and

12 alkyl groups containing one to twenty Carbon atoms.

20. The method as recited in Claim 14 wherein said
2 R_1 and R_2 are H, and R_3 has the general formula: $-(CH_2)_nR_4$ where
3 $n = 1-20$; and
4 R_4 is selected from the group consisting of:
5 Pyridine (Py); and
6 Phenol (Ph).

21. The method as recited in Claim 14 wherein said
2 pendent arms R and R'' are identical, said pendent arms R' and
3 R''' are identical, and said pendent arms R' and R''' are not
4 equal to said pendent arms R and R'' .

22. The method as recited in Claim 21 wherein
2 said pendent arms R and R'' have the general formula:
3 $-CR_1H-CO-NH-CH_2-R_2$; and
4 said pendent arms R' and R''' have the general formula:
5 $-CHR_3-CO-NH-R_4$ wherein
6 said R_1 , R_2 , R_3 , and R_4 comprise organic substituents; and
7 R_2 is not equal to R_4 .

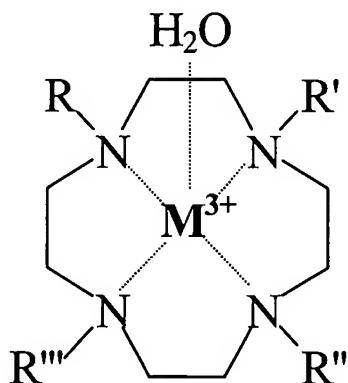
23. The method as recited in Claim 14 further
2 includes obtaining said magnetization transfer signal by

3 applying a radio frequency pulse at a resonance frequency of
4 said protons associated with said amide.

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24. A magnetic resonance system, comprising:

a magnetic resonance (MR) contrast agent, wherein said MR agent tetraazacyclododecane ligand, having a general formula of:



wherein pendent arms R, R', R'' and R''' comprise organic substituents and said tetraazacyclododecane ligand further includes a paramagnetic metal ion (M^{3+}) coordinated to said tetraazacyclododecane ligand and a water molecule (H_2O) associated with said tetraazacyclododecane ligand, wherein said MR contrast agent produces a magnetization transfer signal when subjected to a radio frequency pulse; and

a magnetic resonance apparatus configured to produce said frequency pulse.

25. The magnetic resonance system recited in Claim 24, further comprising a sample containing said MR contrast agent.

26. The magnetic resonance system recited in Claim 24, wherein said sample is a living subject.

27. The magnetic resonance system recited in Claim 24,
2 wherein said magnetic resonance apparatus produces a
3 magnetization transfer image of said sample from said
4 magnetization transfer signal.

28. The magnetic resonance system recited in Claim 27,
2 wherein said magnetic resonance apparatus produces said
3 magnetization transfer image by applying said radio frequency
4 pulse at a resonance frequency of said water molecule.

29. The magnetic resonance system recited in Claim 28,
2 wherein said magnetic resonance apparatus produces a
3 magnetization transfer difference image by applying said radio
4 frequency pulse at a $\Delta\omega$ of said water molecule, acquiring said
5 magnetization transfer signal and subtracting said signal from a
6 MR signal obtained by applying a radio frequency pulse at $-\Delta\omega$.

30. The magnetic resonance system recited in Claim 27,
2 wherein said magnetic resonance apparatus produces said
3 magnetization transfer image by applying said radio frequency
4 pulse at a resonance frequency of protons associated with an
5 amide included in one or more of said pendent arms.

31. The magnetic resonance system recited in Claim 24,
2 wherein said radio frequency pulse is produced by said magnetic
3 resonance apparatus and is a saturating pulse.

32. The magnetic resonance system recited in Claim 24,
2 wherein said saturating pulse is applied at a resonance
3 frequency of said water molecule.

33. The magnetic resonance system recited in Claim 24,
2 wherein said saturating pulse ranges from about 1 to about 3
3 seconds.

34. The magnetic resonance system recited in Claim 24
2 wherein said water molecule has a $\Delta\omega \cdot \tau_M \geq 1$.

35. The magnetic resonance system recited in Claim 24
2 wherein said $\Delta\omega \geq 6$ ppm.

36. The magnetic resonance system recited in Claim 24
2 wherein said $\tau_M \geq 1 \mu s$.